

## **CHAPTER 3 - FLOOD PROOFING PERFORMANCE SUMMARY**

This chapter presents in tabular form data concerning each structure observed, the flooding source and date, the type of flood proofing measure used, and the actual performance of the measure. The data are presented twice so information can easily be sorted by community and by flood proofing measure. Table 1 presents the information sorted by community. Table 2 presents the information sorted by flood proofing measure. See Chapter 2 for a narrative description of the structure, the flood proofing measure used, and the “lessons” gained from observing how the measure worked when tested by flooding.

**TABLE 1**  
**SUMMARY OF FLOOD PROOFING PERFORMANCE**  
**(Organized by Community)**

Structure No.	Community	Structure Type	Flood Source	Flood Date	Flood Proofing Measure	Performance
1	Clive, IA	Residential	Riverine	May 1986	Dry flood proofing	Successful
2	Alma, MI	Commercial	Riverine	Sep 1986	Dry flood proofing	Overtopped
3	Midland, MI	Residential	Riverine	Sep 1986	Dry flood proofing	1>
4	Midland, MI	Residential	Riverine	Sep 1986	Dry flood proofing	Failed
5	Midland, MI	Residential	Riverine	Sep 1986	Dry flood proofing	Failed
6	Midland, MI	Residential	Riverine	Sep 1986	Dry flood proofing	Failed
7	Midland, MI	Residential	Riverine	Sep 1986	Dry flood proofing	Failed
8	Crystal, MN	Residential	Riverine	Jul 1987	Floodwall	Failed
9	Crystal, MN	Residential	Riverine	Jul 1987	Floodwall	Mostly Successful
10	Crystal, MN	Residential	Riverine	Jul 1987	Dry flood proofing	Failed
11	Crystal, MN	Residential	Riverine	Jul 1987	Floodwall	Failed
12	Crystal, MN	Residential	Riverine	Jul 1987	Floodwall	Failed

**TABLE 1 (cont.)**

Structure No.	Community	Structure Type	Flood Source	Flood Date	Flood Proofing Measure	Performance
13	Montgomery Co., TX	Residential	Riverine	Jun 1989	Earthen ring levee/ elevation--extended foundation walls	Successful
14	Montgomery Co., TX	Residential	Riverine	Jun 1989	Dry flood proofing	Successful
15	Montgomery Co., TX	Residential	Riverine	May 1989	Floodwall	Overtopped
16	Montgomery Co., TX	Residential	Riverine	May 1989	Dry flood proofing	Partially Successful
17	Montgomery Co., TX	Residential	Riverine	Jun 1989	Elevation--wood piles	Successful
18	Surfside Beach, SC	Residential	Coastal	Sep 1989	Elevation--steel columns	Successful
19	Surfside Beach, SC	Residential	Coastal	Sep 1989	Elevation--brick piers	Failed
20	Surfside Beach, SC	Residential	Coastal	Sep 1989	Elevation--block piers	Failed
21	Garden City, SC	Residential	Coastal	Sep 1989	Elevation--wood piles	Successful
22	Garden City, SC	Residential	Coastal	Sep 1989	Elevation--wood piles	Successful
23	Pawley's Island, SC	Residential	Coastal	Sep 1989	Elevation--wood piers	Failed
24	Pawley's Island, SC	Residential	Coastal	Sep 1989	Elevation--wood columns	Successful

**TABLE 1 (cont.)**

Structure No.	Community	Structure Type	Flood Source	Flood Date	Flood Proofing Measure	Performance
25	Pawley's Island, SC	Residential	Coastal	Sep 1989	Elevation--concrete piles	Failed
26	Debidue Beach, SC	Residential	Coastal	Sep 1989	Elevation--piles	Failed
27	Debidue Beach, SC	Residential	Coastal	Sep 1989	Elevation--concrete piers	Failed
28	Charleston Co., SC	Residential	Coastal	Sep 1989	Elevation--masonry piers	Failed
29	Charleston Co., SC	Residential	Coastal	Sep 1989	Elevation--masonry piers	Successful
30	Charleston Co., SC	Residential	Coastal	Sep 1989	Elevation--masonry piers	Successful
31	Charleston Co., SC	Residential	Coastal	Sep 1989	Elevation--wood piles	Successful
32	Charleston Co., SC	Residential	Coastal	Sep 1989	Elevation--wood piles	Successful
33	Charleston Co., SC	Residential	Coastal	Sep 1989	Elevation--wood posts	Successful
34	Charleston Co., SC	Residential	Coastal	Sep 1989	Elevation--wood piles	Failed
35	Charleston Co., SC	Residential	Coastal	Sep 1989	Elevation--wood piles	Failed
36	Charleston Co., SC	Residential	Coastal	Sep 1989	Elevation--wood piles	Failed
Structure No.	Community	Structure Type	Flood Source	Flood Date	Flood Proofing Measure	Performance
37	Charleston Co., SC	Residential	Coastal	Sep 1989	Elevation--masonry columns/wood piles	Successful

**TABLE 1 (cont.)**

38	Charleston Co., SC	Residential	Coastal	Sep 1989	Elevation--concrete block	Failed
39	Charleston Co., SC	Residential	Coastal	Sep 1989	Elevation--wood posts	Successful
40	Charleston Co., SC	Residential	Coastal	Sep 1989	Elevation--reinforced concrete columns	Successful
41	Charleston Co., SC	Residential	Coastal	Sep 1989	Elevation--wood piles	Successful
42	Charleston Co., SC	Residential	Coastal	Sep 1989	Elevation--wood piles	Failed
43	Crystal City, MO	Industrial/ Commercial	Riverine	Summer 1993	Levee	Failed
44	Herculaneum, MO	Residential/ Commercial	Riverine	Summer 1993	Floodwall	Failed
45	Barnhart, MO	Residential	Riverine	Summer 1993	Floodwall	Failed
46	Barnhart, MO	Residential	Riverine	Summer 1993	Elevation--extended foundation walls	Failed
47	St. Louis, MO	Commercial Government	Riverine	Summer 1993	Floodwall	Failed
Structure No.	Community	Structure Type	Flood Source	Flood Date	Flood Proofing Measure	Performance
48	St. Genevieve, MO	Commercial	Riverine	Summer 1993	Levee	Successful

**TABLE 1 (cont.)**

49	St. Genevieve, MO	Commercial	Riverine	Summer 1993	Wet flood proofing	Failed
50	St. Genevieve, MO	Commercial	Riverine	Summer 1993	Elevation--fill	Successful
51	St. Louis, MO	Residential	Riverine	Summer 1993	Elevation 2>	Failed
52	Nutwood, IL	Residential	Riverine	Summer 1993	Elevation--extended foundation walls	Failed
53	Nutwood, IL	Residential	Riverine	Summer 1993	Elevation--extended foundation walls	Failed
54	Nutwood, IL	Residential	Riverine	Summer 1993	Elevation--extended foundation walls	Failed
55	Nutwood, IL	Residential	Riverine	Summer 1993	Elevation--extended foundation walls	Failed
56	Herman, MO	Industrial	Riverine	Summer 1993	Floodwall	Failed
Structure No.	Community	Structure Type	Flood Source	Flood Date	Flood Proofing Measure	Performance
57	Ames, IA	Public	Riverine	Jul 1993	Dry Flood proofing w/closures	Failed

**TABLE 1 (cont.)**

58	Ames, IA	Public	Riverine	Jul 1993	Elevation	Failed
59	Houston, TX	Residential	Riverine	Fall 1994	Elevation--wood posts	Failed
60	Houston, TX	Residential	Riverine	Fall 1994	Elevation--wood posts	Successful
61	Houston, TX	Residential	Riverine	Fall 1994	Elevation--wood posts	Failed
62	Houston, TX	Residential	Riverine	Fall 1994	Elevation--wood posts	Successful
63	Houston, TX	Residential	Riverine	Fall 1994	Elevation--wood posts	Successful
64	Houston, TX	Residential	Riverine	Fall 1994	Elevation--masonry columns	Successful
65	Houston, TX	Residential	Riverine	Fall 1994	Elevation--wood posts	Failed
66	Houston, TX	Residential	Riverine	Fall 1994	Elevation--wood posts	Failed
67	Houston, TX	Residential	Riverine	Fall 1994	Elevation--extended foundation walls	Failed
68	Houston, TX	Residential	Riverine	Fall 1994	3>	Failed
69	Houston, TX	Residential	Riverine	Fall 1994	3>	Failed
70	Houston, TX	Residential	Riverine	Fall 1994	3>	Failed
71	Houston, TX	Residential	Riverine	Fall 1994	3>	Failed
Structure No.	Community	Structure Type	Flood Source	Flood Date	Flood Proofing Measure	Performance
72	Panama City, FL	Residential	Coastal	Fall 1995	Elevation--extended foundation walls with seawall	Failed

**TABLE 1 (cont.)**

73	Panama City, FL	Residential	Coastal	Fall 1995	Elevation--extended foundation walls with seawall	Failed
74	Panama City, FL	Residential	Coastal	Fall 1995	Elevation--extended foundation walls	Failed
75	Panama City, FL	Residential	Coastal	Fall 1995	Elevation--extended foundation walls	Failed
76	Panama City, FL	Residential	Coastal	Fall 1995	Elevation--wood piles	Failed
77	Panama City, FL	Residential	Coastal	Fall 1995	Elevation--extended foundation walls	Failed
78	Panama City, FL	Residential	Coastal	Fall 1995	Elevation--wood piles	Failed
79	Panama City, FL	Residential	Coastal	Fall 1995	Elevation--extended foundation walls	Failed
80	Panama City, FL	Residential	Coastal	Fall 1995	Elevation--wood piles	Failed
Structure No.	Community	Structure Type	Flood Source	Flood Date	Flood Proofing Measure	Performance
81	Panama City, FL	Residential	Coastal	Fall 1995	Elevation	Successful



**TABLE 1 (cont.)**

82	Panama City, FL	Residential	Coastal	Fall 1995	Elevation--masonry columns with seawall	Successful
83	Panama City, FL	Motel	Coastal	Fall 1995	Elevation--wood piles	Successful
84	Panama City, FL	Residential	Coastal	Fall 1995	Sand dune	Successful
85	Pensacola, FL	Residential	Coastal	Fall 1995	Elevation--wood frame	Failed
86	Pensacola, FL	Residential	Coastal	Fall 1995	Elevation--wood piles	Successful
87	Pensacola, FL	Residential	Coastal	Fall 1995	Elevation--wood piles	Successful
88	Pensacola, FL	Residential	Coastal	Fall 1995	Elevation--concrete columns	Successful
89	Pensacola, FL	Residential	Coastal	Fall 1995	Elevation--wood piles	Successful
90	Sacramento, CA	Residential	Riverine	Jan 1997	Floodwall	Failed
91	Sacramento, CA	Residential	Riverine	Jan 1997	Levee	Failed
92	Reno, NV	Public	Riverine	Jan 1997	Wet/dry flood proofing	Failed
93	Reno, NV	Commerical	Riverine	Jan 1997	Elevation--fill	Successful
Structure No.	Community	Structure Type	Flood Source	Flood Date	Flood Proofing Measure	Performance

**TABLE 1 (cont.)**

94	Reno, NV	Commerical	Riverine	Jan 1997	Levee	Successful
95	Reno, NV	Commerical	Riverine	Jan 1997	Levee	Successful
96	Ashland, NE	Public	Riverine	Feb 1997	Elevation	Successful
97	East Grand Forks, MN	Residential	Riverine	Apr 1997	Dry flood proofing	Failed
98	Oakport, MN	Residential	Riverine	Apr 1997	Dry flood proofing	Successful

1> Ten structures are represented, 7 of which were damaged and 3 were not damaged.

2> This structure represents the numerous single-family homes and small commerical buildings that are elevated on piles, posts( columns), piers, extended foundations, etc.

3> The structures were so totally destroyed that the flood proofing measure used could not be identified by observation.

**TABLE 2**  
**SUMMARY OF FLOOD PROOFING PERFORMANCE**  
**(Organized by Flood Proofing Measure)**

Structure No.	Flood Proofing Measure	Structure Type	Flood Source	Flood Date	Community	Performance
14	Dry flood proofing	Residential	Riverine	Jun 1989	Montgomery Co., TX	Successful
16	Dry flood proofing	Residential	Riverine	May 1989	Montgomery Co., TX	Partially Successful
10	Dry flood proofing	Residential	Riverine	Jul 1987	Crystal, MN	Failed
2	Dry flood proofing	Commercial	Riverine	Sep 1986	Alma, MI	Overtopped
4	Dry flood proofing	Residential	Riverine	Sep 1986	Midland, MI	Failed
6	Dry flood proofing	Residential	Riverine	Sep 1986	Midland, MI	Failed
7	Dry flood proofing	Residential	Riverine	Sep 1986	Midland, MI	Failed
1	Dry flood proofing	Residential	Riverine	Sep 1986	Clive, IA	Successful
57	Dry flood proofing w/closures	Public	Riverine	Jul 1993	Ames, IA	Failed

**TABLE 2 (cont.)**

Structure No.	Flood Proofing Measure	Structure Type	Flood Source	Flood Date	Community	Performance
97	Dry flood proofing	Residential	Riverine	Apr 1997	East Grand Forks, MN	Failed
98	Dry flood proofing	Residential	Riverine	Apr 1997	Oakport, MN	Successful
3	Dry Flood proofing	Residential	Riverine	Sep 1986	Midland, MI	1>
5	Dry Flood proofing	Residential	Riverine	Sep 1986	Midland, MI	Failed
13	Earthen ring levee/ elevation--extended foundation walls	Residential	Riverine	Jun 1989	Montgomery Co., TX	Successful
51	Elevation 2>	Residential	Riverine	Summer 1993	St. Louis, MO	Failed
52	Elevation--extended foundation walls	Residential	Riverine	Summer 1993	Nutwood, IL	Failed
58	Elevation	Public	Riverine	Jul 1993	Ames, IA	Failed
81	Elevation	Residential	Coastal	Fall 1995	Panama City, FL	Successful
93	Elevation--fill	Commerical	Riverine	Jan 1997	Reno, NV	Successful
96	Elevation	Public	Riverine	Feb 1997	Ashland, NE	Successful

**TABLE 2 (cont.)**

Structure No.	Flood Proofing Measure	Structure Type	Flood Source	Flood Date	Community	Performance
20	Elevation--block piers	Residential	Coastal	Sep 1989	Surfside Beach, C	Failed
19	Elevation--brick piers	Residential	Coastal	Sep 1989	Surfside Beach, SC	Failed
25	Elevation--concrete piles	Residential	Coastal	Sep 1989	Pawley's Island, SC	Failed
27	Elevation--concrete piers	Residential	Coastal	Sep 1989	Debidue Beach, SC	Failed
88	Elevation--concrete columns	Residential	Coastal	Fall 1995	Pensacola, FL	Successful
46	Elevation--extended foundation walls	Residential	Riverine	Summer 1993	Barnhart, MO	Failed
53	Elevation--extended foundation walls	Residential	Riverine	Summer 1993	Nutwood, IL	Failed
54	Elevation--extended foundation walls	Residential	Riverine	Summer 1993	Nutwood, IL	Failed
55	Elevation--extended foundation walls	Residential	Riverine	Summer 1993	Nutwood, IL	Failed
67	Elevation--extended foundation walls	Residential	Riverine	Fall 1994	Houston, TX	Failed

**TABLE 2 (cont.)**

Structure No.	Flood Proofing Measure	Structure Type	Flood Source	Flood Date	Community	Performance
72	Elevation--extended foundation walls with seawall	Residential	Coastal	Fall 1995	Panama City, FL	Failed
73	Elevation--extended foundation walls with seawall	Residential	Coastal	Fall 1995	Panama City, FL	Failed
74	Elevation--extended foundation walls	Residential	Coastal	Fall 1995	Panama City, FL	Failed
75	Elevation--extended foundation walls	Residential	Coastal	Fall 1995	Panama City, FL	Failed
77	Elevation--extended foundation walls	Residential	Coastal	Fall 1995	Panama City, FL	Failed
79	Elevation--extended foundation walls	Residential	Coastal	Fall 1995	Panama City, FL	Failed
50	Elevation--fill	Commercial	Riverine	Summer 1993	St. Genevieve, MO	Successful
28	Elevation--masonry piers	Residential	Coastal	Sep 1989	Charleston Co., SC	Failed

**TABLE 2 (cont.)**

Structure No.	Flood Proofing Measure	Structure Type	Flood Source	Flood Date	Community	Performance
29	Elevation--masonry piers	Residential	Coastal	Sep 1989	Charleston Co., SC	Successful
30	Elevation--masonry piers	Residential	Coastal	Sep 1989	Charleston Co., SC	Successful
37	Elevation--masonry columns/wood piles	Residential	Coastal	Sep 1989	Charleston Co., SC	Successful
38	Elevation--concrete block columns	Residential	Coastal	Sep 1989	Charleston Co., SC	Failed
64	Elevation--masonry columns	Residential	Riverine	Fall 1994	Houston, TX	Successful
82	Elevation--masonry columns/seawall	Residential	Coastal	Fall 1995	Panama City, FL	Successful
26	Elevation--piles	Residential	Coastal	Sep 1989	Debidue Beach, SC	Failed
40	Elevation--reinforced concrete columns	Residential	Coastal	Sep 1989	Charleston Co., SC	Successful
18	Elevation--steel columns	Residential	Coastal	Sep 1989	Surfside Beach, SC	Successful
17	Elevation--wood piles	Residential	Riverine	Jun 1989	Montgomery Co., TX	Successful

**TABLE 2 (cont.)**

21	Elevation--wood piles	Residential	Coastal	Sep 1989	Garden City, SC	Successful
Structure No.	Flood Proofing Measure	Structure Type	Flood Source	Flood Date	Community	Performance
22	Elevation--wood piles	Residential	Coastal	Sep 1989	Garden City, SC	Successful
23	Elevation--wood columns	Residential	Coastal	Sep 1989	Pawley's Island, SC	Failed
24	Elevation--wood columns	Residential	Coastal	Sep 1989	Pawley's Island, SC	Successful
31	Elevation--wood piles	Residential	Coastal	Sep 1989	Charleston Co., SC	Successful
32	Elevation--wood piles	Residential	Coastal	Sep 1989	Charleston Co., SC	Successful
33	Elevation--wood posts	Residential	Coastal	Sep 1989	Charleston Co., SC	Successful
34	Elevation--wood piles	Residential	Coastal	Sep 1989	Charleston Co., SC	Failed
35	Elevation--wood piles	Residential	Coastal	Sep 1989	Charleston Co., SC	Failed
36	Elevation--wood piles	Residential	Coastal	Sep 1989	Charleston Co., SC	Failed
39	Elevation--wood posts	Residential	Coastal	Sep 1989	Charleston Co., SC	Successful
41	Elevation--wood piles	Residential	Coastal	Sep 1989	Charleston Co., SC	Successful
42	Elevation--wood piles	Residential	Coastal	Sep 1989	Charleston Co., SC	Failed
59	Elevation--wood posts	Residential	Riverine	Fall 1994	Houston, TX	Failed



**TABLE 2 (cont.)**

Structure No.	Flood Proofing Measure	Structure Type	Flood Source	Flood Date	Community	Performance
60	Elevation--wood posts	Residential	Riverine	Fall 1994	Houston, TX	Successful
61	Elevation--wood posts	Residential	Riverine	Fall 1994	Houston, TX	Failed
62	Elevation--wood posts	Residential	Riverine	Fall 1994	Houston, TX	Successful
63	Elevation--wood posts	Residential	Riverine	Fall 1994	Houston, TX	Successful
65	Elevation--wood posts	Residential	Riverine	Fall 1994	Houston, TX	Failed
66	Elevation--wood posts	Residential	Riverine	Fall 1994	Houston, TX	Failed
76	Elevation--wood piles	Residential	Coastal	Fall 1995	Panama City, FL	Failed
78	Elevation--wood piles	Residential	Coastal	Fall 1995	Panama City, FL	Failed
80	Elevation--wood piles	Residential	Coastal	Fall 1995	Panama City, FL	Failed
83	Elevation--wood piles	Motel	Coastal	Fall 1995	Panama City, FL	Successful
85	Elevation--wood frame	Residential	Coastal	Fall 1995	Pensacola, FL	Failed
86	Elevation--wood piles	Residential	Coastal	Fall 1995	Pensacola, FL	Successful
87	Elevation--wood piles	Residential	Coastal	Fall 1995	Pensacola, FL	Successful
89	Elevation--wood piles	Residential	Coastal	Fall 1995	Pensacola, FL	Successful

**TABLE 2 (cont.)**

Structure No.	Flood Proofing Measure	Structure Type	Flood Source	Flood Date	Community	Performance
15	Floodwall	Residential	Riverine	May 1989	Montgomery Co., TX	Overtopped
8	Floodwall	Residential	Riverine	Jul 1987	Crystal, MN	Failed
9	Floodwall	Residential	Riverine	Jul 1987	Crystal, MN	Mostly Successful
11	Floodwall	Residential	Riverine	Jul 1987	Crystal, MN	Failed
12	Floodwall	Residential	Riverine	Jul 1987	Crystal, MN	Failed
44	Floodwall	Residential/ Commercial	Riverine	Summer 1993	Herculaneum, MO	Failed
45	Floodwall	Residential	Riverine	Summer 1993	Barnhart, MO	Failed
47	Floodwall	Commercial Government	Riverine	Summer 1993	St. Louis, MO	Failed
56	Floodwall	Industrial	Riverine	Summer 1993	Herman, MO	Failed
90	Floodwall	Residential	Riverine	Jan 1997	Sacramento, CA	Failed

**TABLE 2 (cont.)**

Structure No.	Flood Proofing Measure	Structure Type	Flood Source	Flood Date	Community	Performance
43	Levee	Industrial/ Commercial	Riverine	Summer 1993	Crystal City, MO	Failed
48	Levee	Commercial	Riverine	Summer 1993	St. Genevieve, MO	Successful
91	Levee	Residential	Riverine	Jan 1997	Sacramento, CA	Failed
94	Levee	Commerical	Riverine	Jan 1997	Reno, NV	Successful
95	Levee	Commerical	Riverine	Jan 1997	Reno, NV	Successful
84	Sand dune	Residential	Coastal	Fall 1995	Panama City, FL	Successful
49	Wet flood proofing	Commercial	Riverine	Summer 1993	St. Genevieve, MO	Failed
92	Wet/dry flood proofing	Public	Riverine	Jan 1997	Reno, NV	Failed
68	3>	Residential	Riverine	Fall 1994	Houston, TX	Failed

**TABLE 2 (cont.)**

Structure No.	Flood Proofing Measure	Structure Type	Flood Source	Flood Date	Community	Performance
69	3>	Residential	Riverine	Fall 1994	Houston, TX	Failed
70	3>	Residential	Riverine	Fall 1994	Houston, TX	Failed
71	3>	Residential	Riverine	Fall 1994	Houston, TX	Failed

1> Ten structures are represented, 7 of which were damaged and 3 were not damaged.

2> This structure represents the numerous single-family homes and small commercial buildings that are elevated on piles, posts(columns), piers, extended foundations, etc.

3> The structures were so totally destroyed that the flood proofing measure used could not be identified by observation.